LPA²

Analyser

User Guide

MPFILTRI®

www.mpfiltri.co.uk

200.053-EN

Covers Model Numbers

LPA²

SAFETY WARNING

Hydraulic systems contain dangerous fluids at high pressures and temperatures. Installation, servicing and adjustment is only to be performed by qualified personnel.
Do not tamper with this device.

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1 Precautions

The default language setting for the LPA² Laser Particle Analyser is *English*. To change the language setting refer to page 12.

1.1 Battery

It is recommended that the LPA² be charged for a minimum of 24 hours prior to first use, to fully charge the internal battery.

1.2 Internal Cleaning

Do NOT clean the LPA² or Bottle Sampler with Acetone or similar solvents that are not compatible with the seals in the LPA². The recommended cleaning fluid for internal flushing is Petroleum Ether - see also Fault Finding, page 65.

The use of a 500µm coarse screen filter, screwed onto the HP connector, is recommended for heavily contaminated systems. Refer to page 62 for the part number.

1.3 LCD Visibility

If the LCD screen remains blank then refer to page 35 for recharging instruction. To improve the LCD screen visibility, the Analyser can be inclined by unlatching the two extension feet fitted to the bottom of the case.

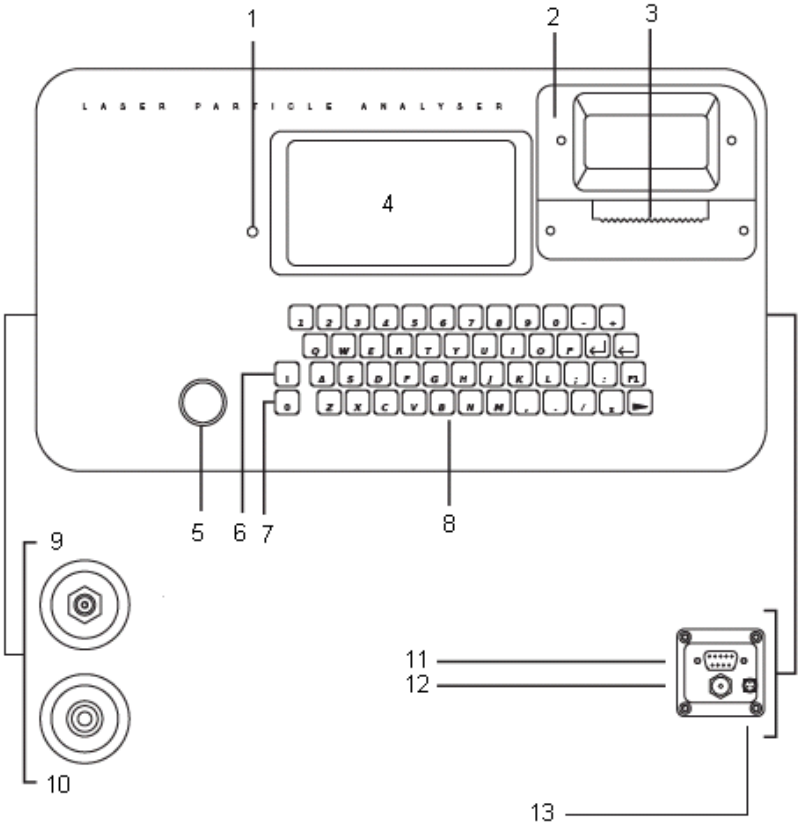
2 Introduction

The LPA² is designed to measure and quantify the numbers of solid contaminants in Hydraulic, Lubrication and Transmission applications. The LPA² is designed to be a laboratory accurate instrument suitable for "on-site'' applications utilising mineral oil as the operating fluid. Please contact local sales office for other operating fluid options.

The instrument uses the light extinction principle whereby 2 laser light systems shine through the fluid and lands on photodiodes. When a particle passes through the beam it reduces the amount of light received by the diode, and from this change in condition, the size of the particle can be deduced.

Hydraulic and Lubricating Systems consists of sets of continuously moving metal parts, which use hydraulic fluid as the power medium. Hydraulic fluid is also used to create a lubrication film to keep the precision parts separated and it is also used as a cooling medium. The very nature of a hydraulic system is that it produces solid particulate contaminants and these are ever present in all hydraulic systems. There is a revised standard ISO cleanliness code ISO 4406: 1999 which classifies the numbers of particles that can be tolerated within the system and it is these levels of contaminants that the particle counter is designed to measure.[1]

[1] *ISO Cleanliness Code* – The international standard for reporting solid contaminants is ISO4406:1999, this standard has been revised to incorporate the change to ISO Medium Test Dust as the calibration standard.



1	Battery charging indicator
2	Printer
3	Serrated Paper Cutter
4	Screen
5	Flush valve push button
6	On
7	Off
8	Keyboard
9	HP connector – Minimess
10	Waste connector – Quick coupling
11	RS232 connector
12	DC power input socket
13	Plug to external circuits

3 Online Operation

1. Insert ***WASTE FLUID HOSE*** in to the waste disposal bottle provided.

> *Important! Do not connect Waste Fluid Hose to a pressurised system, as this will cause the Analyser to malfunction and could cause internal leakage. The Waste Fluid Hose must be discharged into the waste disposal bottle provided, or into a tank/vessel vented to atmosphere.*

2. Connect ***WASTE FLUID HOSE*** to Analyser (waste connector). Push back quick coupling outer ring before connecting / disconnecting hose end.

3. Connect ***FLUID SAMPLING HOSE*** to Analyser (HP connector)

4. Connect ***FLUID SAMPLING HOSE*** to the system by means of the minimess connector.

> *The system to be monitored must not exceed 400 bar or be less than 2 bar*

5. Press ***GREEN BUTTON*** to switch on Analyser the "Main / test progress screen'' will be displayed.

To prolong battery life it is advisable to switch off the Analyser when not in use.

3.1 Main / Test Progress Screen

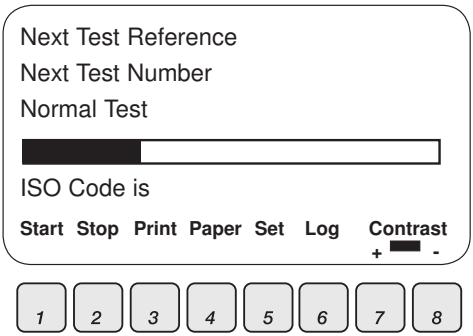


Figure 3.1 Main Test Screen

1 START - Starts sampling and emptying cycle

2 STOP - Stops test at any point in the sampling/ emptying cycle. Next test will start with an emptying cycle before the test commences,

3 PRINT - Prints test results. If AUTO PRINT mode has been turned off, a copy of the results is obtained by pressing PRINT button.

4 PAPER - Ejects printer paper by three blank lines.

5 SET - Selects settings screen – see page 11

6 LOG - Selects Data Logging screen – see page 34

- Transfer log – downloads memory to software package[2]
- Clear log – Clears memory
- Clear last – Clears last result[3]
- Recall – Recalls results from memory
- Print – Prints recalled results

7 8 CONTRAST +/-: Adjusts the screen contrast. 7 Darker 8 Lighter.

LOW BATTERY INDICATOR – see page 35

[2] This is not needed on new units
[3] Provided unit has not been switched off

3.2 Analyser Settings

Press the SET button [5] to program the Analyser to your requirements. The main "Settings Screen'' will be displayed. To alter the Analyser settings progress through the following routine from this screen.

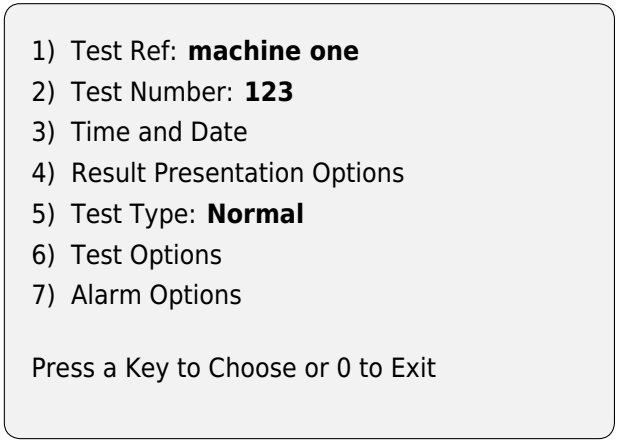

1) Test Ref: **machine one**
2) Test Number: **123**
3) Time and Date
4) Result Presentation Options
5) Test Type: **Normal**
6) Test Options
7) Alarm Options
Press a Key to Choose or 0 to Exit

Figure 3.2 Main Settings Screen

3.2.1 Test Ref

1 Press [1], then input your reference details e.g. "MACHINE 1←" (RETURN). 15 characters maximum.

3.2.2 Test Number

2 Press [2], then input the required test number e.g. "123←". The Test Number will automatically increment for each successive test.

3.2.3 Time and Date

3 Press [3], then use the keypad to set the time and date.

Cycle Count

A cumulative cycle count is also displayed on the Time & Date screen. This count automatically increases by 1 each time a test is taken. It is not possible to adjust/ reset this value.

3.2.4 Result Presentation Options

4 Press [4] to bring up the Presentation Options screen. Then press the relevant key to switch between the option selections.

[1] cycles between the various available formats for the test result. These are ISO, NAS, AS4059E-2 and AS4059E-1.[4]

[2] turns on and off the printing of detailed counts with the test result.

[3] turns on and off the printing of the user Test Reference.

[4] turns on and off automatic result printing.

[5] turns on and off the printing of an additional space for hand-written notes on the printout.

[6] selects the display language.

Note the Analyser has 5 language options:

[4] AS4059E-1 and AS4059E-2 denotes Table 1 and Table 2 of the AS4059E standard respectively

0. English (Default)
1. Italian
2. French
3. German
4. Chinese

For selection of language proceed as follows:

– Press [6].
– Enter chosen value (e.g. 1←for Italian).
– Press key [0] (zero)
– Press key [0] (zero)
– Wait 5 seconds
– Switch OFF the unit
– RESTART the unit.
– The main screen will then be displayed in the language selected.

3.2.5 Test Type

5 Button [5] is used from the Settings Screen to cycle between the available test types. These are "Normal'', "Dynamic'', "Triple/Bottle" "Continuous'' and "Short Sample''. The selection will be displayed on the Main test progression screen

Normal – Single Test: 15ml sample volume

Dynamic – A comprehensive triple test[5] with results average: 30 ml sample volume comprised of three 10ml sampling and emptying cycles. Allows the effect of system fluctuations to be measured over

[5] Results will be displayed upon completion of three tests – including emptying cycle

a longer period of time. Unit is flushed in between tests to ensure each sample is representative of its point in time.

Triple / Bottle Sampling – A triple test with results average and quicker than the Dynamic Test: 24ml sample volume comprised of three individual 8 ml samples tested consecutively. For Bottle Sampling refer to separate User Guide.

Continuous – for detailed instructions refer to Continuous Sampling, page 19.

Short – Single Test: 8 ml sample volume. This provides results in less time than the Normal Test. It is not recommended for oil samples cleaner than ISO 17/15/12 (NAS 6), as the accuracy of the result might be compromised by the 'small' sample volume

Press 5 repeatedly to select desired test type.

3.2.6 Test Options

Press 6. The Test Options Screen will be displayed.

(The RH Test setting is not displayed if the option is not fitted)

This mainly applies to the continuous test mode. Option 3 only applies to the Continuous Test, alarm mode 1. For detailed instructions refer to Continuous Sampling, page 19.

7 Alarm Options – refer to page 28

3.3 Preparing Analyser For Test

Taking sample – Normal, Dynamic, Triple/ Bottle, Short

8 Press flush valve push button to open flush valve – push button illuminates to indicate valve is open. Leave valve open for at least one minute or 200ml of fluid, to remove any entrapped air and fluid from the previous test ensuring no cross-contamination between samples.

9 Press flush valve push button to close flush valve – push button illumination is cancelled. Alternatively, proceed to step 10 – the action of pressing Start button automatically closes the Flush valve before sampling commences.

10 Press START button: The analyser will now commence the sampling cycle.

11 The completion progress bar indicated the status of the sample.

- Results will be automatically displayed on the screen.
- Results will be automatically printed at the end of the sampling cycle, if the Auto Print mode has been turned ON.
- *If the Auto Print mode has been turned OFF, then press Print key to obtain printed results.*

12 Following the sampling results the Analyser automatically discharges the sample fluid to waste. Test status is shown as Emptying.

13 When the Sampling and Emptying cycle has been completed the test status is shown as Idle.

Results are automatically stored to memory. To download results follow instructions on page 34.

3.4 Interpreting Results

Refer to page 49 for hydraulic component manufacturers recommendations on standard cleanliness requirements for various applications. ISO4406:1999 and NAS1638 cannot be directly compared.

TEST NUMBER 39
TEST REF CALIBRATION
TEST TYPE: Normal
ISO CODE:-

19/18/13

NAS CODE 10
SAMPLE VOLUME 15ml

µm(c)	/100ml
4	451977
6	186068
14	5784
21	2064
25	1344
38	240
50	24
70	0

ONLINE – Normal
Particle count
and ISO code to
ISO4406:1999 standard

TEST NUMBER 39
TEST REF CALIBRATION
TEST TYPE: Dynamic
ISO CODE:-

15/14/11

NAS CODE 6
SAMPLE VOLUME 24ml

µm(c)	/100ml	/100ml	/100ml	Average
4	29092	27370	34069	30177
6	11675	12058	17417	13716
14	1132	1274	1062	1156
21	283	389	424	365
25	177	318	212	235
38	35	35	70	46
50	0	0	0	0
70	0	0	0	0

ONLINE – Dynamic
ISO and NAS Code complete
with average analysis

TEST NUMBER 39
TEST REF CALIBRATION
TEST TYPE: Normal
NAS CODE:-

7

µm	5-15	15-25	25-50	50-100	100+
NAS	6	5	7	7	00

ISO CODE 16/15/12
SAMPLE VOLUME 15ml

µm	/100ml
5-15	15860
15-25	1239
25-50	952
50-100	132
100+	0

ONLINE – Normal
Particle counts displayed –
NAS code 1638 standard

```
TEST NUMBER      39
TEST REF         CALIBRATION
TEST TYPE:       Normal
ISO CODE:-

              */*/*

NAS CODE **
SAMPLE VOLUME 15ml

µm(c)     /100ml
4     XXXXXXXXX
6     XXXXXXXXX
14    XXXXXXXXX
21    XXXXXXXXX
25    XXXXXXXXX
38    XXXXXXXXX
50    XXXXXXXXX
70    XXXXXXXXX
```

The Analyser upper operating limit is set at 24/22/20.

Tests that result in particle counts exceeding any scale number in the three part ISO code upper limit has the scale number replaced by an asterisk. Also, the associated particle counts on the printout are replaced by X's. Refer to the example on the left.

3.5 Further Tests

3.5.1 Same Sampling Point

To repeat a test on the same sample point press START button [1].

Note that the test number will automatically increment.

3.5.2 Different Sampling Point/ Same System

To carry out this new test repeat steps 8 to 13 on page 14.

To change test reference/ test mode data, repeat steps 1 to 13 on page 11.

3.5.3 New System

To carry out this test repeat steps 1 to 13 on page 11.

3.6 Shutting Down

1. Disconnect the *Fluid Sampling Hose* from the system by means of the Minimess connector. This isolates the fluid supply.
2. Operate the *Flush Valve* to release the pressure.
3. Switch off the Analyser by Pressing the *Red Button*.
4. Remove the *Fluid Sampling Hose* from the Analyser
5. Remove the *Waste Fluid Hose* from the Analyser
6. Replace the *Hose End Caps* on sampling hose, wipe clean and store
7. Connect the *Waste Fluid Hose* quick coupling end fittings together, wipe clean and store.

4 Continuous Sampling

The LPA² can be selected for continuous testing at set time intervals.

Once continuous sampling has started the LPA²'s flush valve automatically opens and closes before each test. This allows representative fluid to reach the sensing arrangement before the 15ml sampling test commences.

The flush valve automatically opens at the end of the sampling cycle and remains open whilst the LPA² is emptying to waste the sample fluid from the previous test. Additionally, depending on the time set for Minutes Between Tests, the flush valve operates as follows:-

- Time set to 0:

  At the end of the Analyser's emptying cycle the Flush valve automatically closes and the next sampling test immediately starts.

- Time set to between 1 and 5:

  After the Analyser's emptying cycle has finished the Flush valve remains open for the time set, then automatically closes before the next sampling test.

- Time set to between 6 and 30000:

  Flush valve automatically closes after the emptying cycle has finished and remains closed until 5 minutes before the next sample test is programmed to start.

The Flush valve status is indicated by the push button illumination. Not illuminated means valve closed, illuminated means valve open.

The servo motor operating the Flush valve exhibits a slight 'ticking' noise, both when it is open and closed. This is normal.

Important! Do not connect Waste Fluid Hose to a pressurised system, as this will cause the LPA² to malfunction and could cause internal leakage. The Waste Fluid Hose must be discharged into a tank/ vessel vented to atmosphere.

To conserve battery life, the LPA² should be permanently connected to the power adaptor when it is operated in the continuous sampling mode.

4.1 Continuous Sampling – Basic Operation

1 See page 11, instructions 1 to 5 inclusive, to select the appropriate LPA² settings.

On the Settings Screen, press [5] repeatedly until CONTINUOUS is selected.

2 Test Option – Press [6]:

Then press the relevant key to switch between option selections:

[1] Sets the MINUTES BETWEEN TESTS

Press [1] then input the time in minutes that is required between the end of a test and the beginning of a new test. Input a value between 1 and 30000 followed by ←RETURN.

[2] selects between LOG EVERY TEST: ON and LOG EVERY TEST: OFF

Selecting LOG EVERY TEST: OFF will store none of the test results in the LPA²'s memory.

[4] used to input the Clean Alarm Level (ISO). Enter a value of 0 (zero) if not used.

5 used to input the Clean Alarm Level when using the NAS1638 / AS4059E-1 format. Enter 0 if not used.

6 used to enter the Clean Alarm Level when using the AS4059E-2 format. Enter 0 if not used. (This Alarm Level will now be displayed as *A/*B/*C/*D/*E/*F).

3 Press the flush valve push button to open the flush valve. The push button illuminates to indicate that the valve is open. Leave valve open for at least 1 minute or 200ml of fluid, or more if the HP sampling hose is greater than 1.5m long.

4 Press flush valve push button to close flush valve – push button illuminates is cancelled. Alternatively, proceed to Step 5 below – the action of pressing Start button automatically closes the flush valve before sampling commenced.

5 Press the START button 1

The LPA² will now commence the sampling procedure.

6 The completion progress bar indicates the status of the test.

- Results will be automatically displayed on the screen after each test.

- Results will be automatically printed at the end of the emptying cycle, if the Auto Print mode has been turned ON

7 The status is shown as Waiting between the ending of one test and the starting of the next

8 Press Stop button 2 at any point in the cycle to end continuous sampling. The test status will show Idle.

4.1.1 Continuous Sampling – with Clean Alarm Levels – Alarm Mode 1

This operating mode is similar to the Basic Operation, but in this mode the LPA² will stop testing when the specified clean alarm level is achieved.

A status of COMPLETED is shown on the LCD when the specified clean alarm level is achieved.

(For other Alarm Modes refer to page 30).

9 Follow the section "Analyser Settings" (page 11), instructions 1 to 5 inclusive, to select the appropriate LPA² settings.

On the Settings Screen, press [5] repeatedly until CONTINUOUS is selected

10 Test Options [6]

Press relevant key to switch between option selections

[1] Enter MINUTES BETWEEN TESTS

Press [1] then input the time in minutes that is required between the end of a test and the beginning of a new test. Input a value between 1 and 30000 followed by ←RETURN.

[2] Selects between LOG EVERY TEST: ON and LOG EVERY TEST: OFF

Selecting Log Every Test: Off will only store the results of the test when the Clean alarm Level is achieved – this saves memory space.

[3] Confirm Cleanliness Level

Press [3] to turn CONFIRM CLEANLINESS LEVEL On and Off.

Selecting CONFIRM CLEANLINESS LEVEL: ON instructs the Analyser to repeat the sampling cycle until the Clean alarm level has been achieved in two consecutive samples, before the Completed status is displayed. Selecting CONFIRM CLEANLINESS LEVEL: OFF permits the Clean alarm to be achieved only one time before the Completed status is displayed.

4 Clean Alarm Level (ISO)

Press 4 then input desired Clean Alarm Level in the Code format Number/ Number/ Number – any code number combination can be input, from code 5 to 24, example 10/9/5 ←RETURN

For continuous testing until the ISO Code is achieved, selected ISO Format, as described under the previous section on page 11 "Analyser Settings" instruction 4, 1.

Testing will automatically continue until each of the three numbers in the Code have been achieved (or better).

5 Clean Alarm Level (NAS1638 / AS4059E-1)

Press 5 then input desired Clean Alarm Level, as a single Class number in the range 2 to 12 inclusive, example 6←RETURN

For continuous testing until the (NAS1638 / AS4059E-1) Class is achieved, select NAS Format or AS4059E Table 1, as described in "Analyser Settings" page 11 instruction 4, 1. Testing will automatically continue until the Class number has been achieved at each of the five micron size ranges covered by NAS 1638 & AS4059E Table 1. Note: AS4059E-1 denotes Table 1 of the AS4059E standard.

6 Clean Alarm Level (AS4059E-2)

Press 6 then input desired Clean Alarm Level in the format 1A/2B/3C/4D/5E/6F in the following range:

Size Code A: 000to 12
Size Code B: 00 to 12
Size Code C: 00 to 12
Size Code D: 2 to 12
Size Code E: 4 to 12
Size Code F: 7 to 12

Example, 4A/4B/5C/6D/6E/7F

For continuous testing until the AS4059E Table 2 size codes are achieved, select AS4059E TABLE 2 FORMAT, as described in "Analyser Settings" page 11 instruction 4, 1. Testing will automatically continue until the Class number has been achieved at each of the six Size Codes.

Also, the LPA² will handle deviations from the above format intelligently. The size code can be out of order: 7F / 4A / 5C / 4B / 6E / 6D

If any sizes are missing, they will be assigned the "*" value. The effect of this is a "don't care" value when used as the cleanliness target. For example, 6B/6C/7D is translated as *A/6B/6C/7D/*E/*F. In this case, testing will continue until the B, C and D Classes are less than or equal to 6, 6, 7 respectively. The A, E and F Classes are effectively ignored since they cannot ever be " worse" than a "*" Class. Note: AS4059E-2 denotes Table 2 of the AS4059E standard.

11 Press flush valve push button to open flush valve – push button illuminates to indicate valve is open. Leave valve open for at least one

minute or 200ml of fluid, to remove any entrapped air and fluid from the previous test ensuring no cross-contamination between samples.

12 Press flush valve push button to close flush valve – push button illumination is cancelled. Alternatively, proceed to step 13 – the action of pressing Start button automatically closes the Flush valve before sampling commences.

13 Press START button [1]

The Analyser will now commence the sampling cycles

14 The completion progress bar indicates the status of the test.

- Results will be automatically displayed on the screen after each test.

- Results will be automatically printed at the end of the emptying cycle, if the Auto Print mode has been turned ON.

15 The status is shown as Waiting between the ending of one test and the stating of the next test.

16 Press Stop button (key 2) at any time in the cycle to end continuous sampling. The test status will show Idle.

5 Moisture Sensor

The LPA² version fitted with the optional moisture sensor module allows both measurement of % saturation of water in oil (Relative Humidity) and temperature. These are displayed as RH % and °C on the main/test progress screen and on the printed results.

Temperature measurement provides a reference temperature for the RH reading.

> Due to the temperature gradient existing between the system tapping point and the RH/temperature module, the temperature reading can be 5°C to 10°C less than the actual system temperature, depending on operating conditions.

The LPA² can be configured to do a test with or without the moisture sensor selected. If the moisture sensor has been selected, the flush valve will open automatically for a period of 3 minutes before the particle count test commences. This is to allow the moisture sensor to stabilise and give an accurate reading.

To switch the moisture sensor ON or OFF, select the Test Option Screen, as described on page 14. The Test Options Screen will be displayed.

1) Minutes Between Tests: **0**
2) Log Every Test: **On**
3) Confirm Cleanliness Level: **Off**
4) Clean Alarm Level (ISO): **0**
5) Clean Alarm Level (NAS1638/AS4059E-1):**0**
6) Clean Alarm Level (AS4059E-2): **1A/2B/3C/4D/5E/6F**
7) RH Test: On

Press a Key to Choose or 0 to Exit

Press 7 to change RH Test status to ON or OFF.

6 Alarms

Access the Operations screen as described on page 11 and press 7 ALARM OPTIONS. The Alarm Options screen will be displayed.

```
1) Alarm Mode: 1
2) Dirty Alarm Level (ISO): 0
3) Dirty Alarm Level (NAS1638 / AS4059E-1):
   0
4) Dirty Alarm Level (AS4059E-2):
   1A/2B/3C/4D/5E/6F

Press a Key to Choose or 0 to Exit
```

The LPA² includes two solid state relays for connections to an external circuit. These can be arranged to function as follows:

1 Alarm Mode: 0

Selecting option 0 switches relays 1 and 2 always off.

2 Alarm Mode: 1

Selecting option 1 will configure relays 1 and 2 as described on page 31 - refer to the examples given on the simple wiring diagrams.

Clean alarm levels are set in accordance with the instructions starting on page 22. Alarm mode 1 is used in conjunction with the Continuous Sampling test type, enabling the Analyser to operate continuously until the specified clean alarm level is achieved.

3 Alarm Mode: 2

Selecting option 2 arranges the relays to operate when the Clean and Dirty alarm levels are reached/exceeded. Alarm mode 2 will normally be used in conjunction with the Continuous test type (refer to page 20), but can be used with all other test types as well.

Set the Clean and Dirty alarm levels by inputting the desired levels in to both the Test options screen (page 14) and the Alarm options screen, also setting the appropriate result format to ISO, NAS or AS4059, as described on page 12.

Both relays are initially off and remain off until an alarm level has been reached/exceeded.

The following illustrates the switching logic of the Relays :-

Relay 1 (Dirty)

NAS/AS4059E-1 single number	result > set limit	On
	result <= set limit	Off
ISO/AS4059E-2 multi-part	any result > corresponding set limit	On
	all results <= corresponding set limit	Off

Relay 2 (Clean)

NAS/AS4059E-1 single number	result <= set limit	On
	result > set limit	Off

ISO/AS4059E-2 multi-part	all results <= corresponding set limit	On
	any result > corresponding set limit	Off

Alarm Modes: 3 and 4

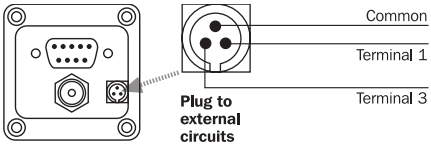
These are reserved for future development.

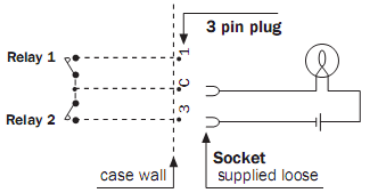
7 Wiring

The LPA² contains two solid state relays which can be used to switch an external circuit, when using the Continuous Test mode. The function of these relays for Alarm Mode 1 is shown in the following simple wiring diagrams, using a battery and bulb circuit for illustrative purposes.

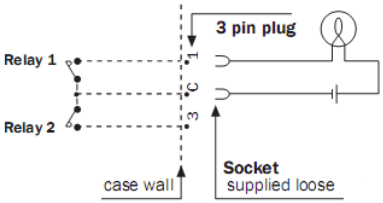
Each relay is designed for a maximum current of 1 amp at 24 volt nominal AC or DC (absolute maximum 60 volt peak). Operation above these limits will cause irreparable damage to the relays.

If the User needs to switch voltages/currents in excess of the above maximum limits, then separate higher rated interposing relays will need to be incorporated into the final electrical scheme designed by the User.





Example 1: Bulb illuminates when Clean alarm level is achieved (completed status), and is off during sampling.



Example 2: Bulb illuminates during sampling and extinguishes when Clean alarm level is achieved (completed status is shown on LPA²). (Relay 1 is also closed during Normal, Dynamic, Triple & Bottle and Short test types. Relay will open when stop button is pressed)

8 Bottle Sampling

An alternative to operating on-line is to use MP Filtri UK's Bottle Sampling Unit to test oil contained in bottles. Refer to the separate User Guide for details.

9 Data Logging

Press the Log button [6] to access results stored within the LPA²'s memory, the Log Screen will be displayed.

```
1) Transfer Log

2) Clear Log

3) Clear Last

4) Recall

5) Print

Press a Key to Choose or 0 to Exit
```

To view the contents of the LPA²'s memory progress through the following routine -

- Select [4] Recall and enter the number of the test to be retrieved.
- If the test number is not known enter the last test number and scroll through the memory, using [+] Next or [-] Previous to select the required result.
- To print the result press [0] EXIT, then [5] Print. A hard copy of the result will then be printed.[6]

[6] The result printed will be viewed in the Result Presentation Options format from the Set function.

10 Battery Charging

The LPA² is equipped with an internal rechargeable battery capable of sustaining 8 hours continuous operation following a 24 hour charging period (approximately 100 tests).

To conserve battery power the LCD screen is illuminated at a reduced level when the LPA² is operated without an external power supply connected.

When the Low battery level indicator is displayed the LPA² requires recharging as soon as possible.

> BEFORE COMMENCING RECHARGING always press RED button to switch off the Analyser.

To recharge, connect lead from power adaptor to the DC power input socket on the LPA². Observe that the battery charging indicator illuminates on the LPA².

Battery power may be conserved by:

- Operating LPA² whilst connected to power adaptor
- Switching LPA² OFF between samples
- Turning Auto Print Mode OFF

Should the battery become completely discharged it is advisable to allow a minimum of 15 minutes charge time prior to commencing a test. The LPA² must remain connected to the power adaptor during subsequent tests until the battery has had time to recharge.

Total discharge will shorten the battery lifetime so should be avoided where possible.

11 Printer Paper

To access the thermal printer, remove the four thumbscrews securing the cover and serrated paper cutter. Thermal printer paper is sensitised on one side only and must be fed into the printer mechanism as shown below.

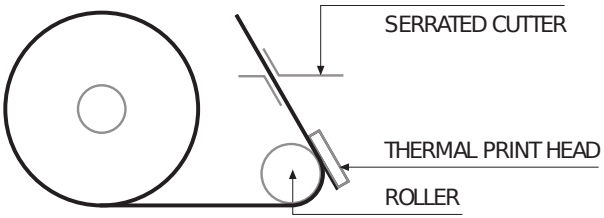


Figure 11.1 Printer Mechanism

Using a finger, press down on the print head spring at *position A* and tilt the print head to the open position by pulling it back at *point B*.

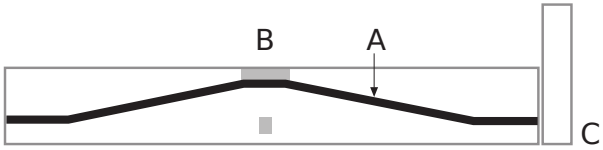


Figure 11.2 Print Head Spring

Feed the paper under the roller and pull the paper end out of the mechanism. Return the print head back to its normal position by pressing on the green lever at *point C*. Ensure that the print head spring has returned to the position shown above.

IMPORTANT The thermal printer must not be operated without paper, as this will damage the printer. Therefore, replace the roll when the "end of the roll'' indication appears on the paper.

12 Computer Analysis

12.1 Software Installation

Install software on to a suitable PC running Windows XP or later. Follow instructions as detailed in the LPA-View User Manual.

12.2 Results Download

1 Connect RS232 cable to LPA² and PC via an appropriate port.[7]

2 Switch ON the LPA².

3 Switch ON the PC.

- Launch LPA-View software.
- From File select Upload.
- Data Transfer Screen will be displayed.
- Select appropriate COM Port.
- Select Transfer Data.

The Analyser will download all stored results from memory into the software package. Upon completion of upload the Analyser memory can be automatically deleted - if this option has been selected from the PC menu.

4 When the transfer is complete switch OFF the Analyser.

[7] See Appendix on page 63 for more information on the RS232 connection options.

13 Warranty

The LPA² is guaranteed for 12 months upon receipt of the Analyser, subject to it being used for the purpose intended and operated in accordance with this user guide. Please fill in online

13.1 Recalibration

MP Filtri UK will only verify the accuracy of the LPA² if the unit is recalibrated every 12 months.

> Please ensure that the test results in the Log are downloaded to LPA-View before the LPA² is despatched, in case action taken by MP Filtri UK during the service / recalibration causes the Log to be cleared.

It is requested that only the LPA², not the support case or any other ancilliaries, be returned for recalibration.

MP Filtri UK will not be held responsible for any items returned as such.

Ensure that the LPA² is packed appropriately for transportation.

Measuring Water in Hydraulic and Lubricating Fluids

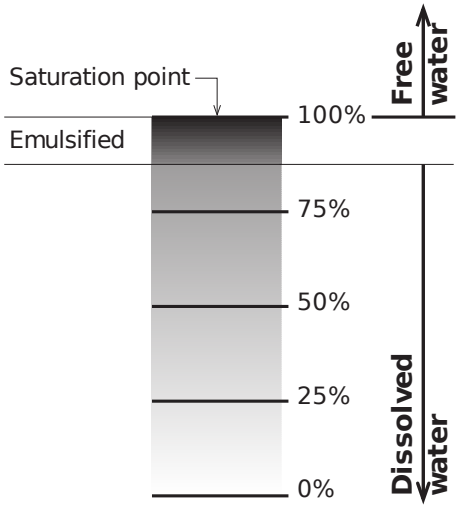
From North Notts Fluid Power Centre

In mineral oils and non aqueous fire resistant fluids water is undesirable. Mineral oil usually has a water content of 50-300 ppm which it can support without adverse consequences.

Once the water content exceeds about 500ppm the oil starts to appear hazy. Above this level there is a danger of free water accumulating in the system in areas of low flow. This can lead to corrosion and accelerated wear. Similarly, fire resistant fluids have a natural water content which may be different to mineral oils.

Saturation Levels

Since the effects of free (also emulsified) water is more harmful than those of dissolved water, water levels should remain well below the saturation point. However, even water in solution can cause damage and therefore every reasonable effort should be made to keep saturation levels as low as possible. There is no such thing as too little water. As a guideline, we recommend maintaining saturation levels below 50% in all equipment.



Typical Water Saturation Levels For New Oils

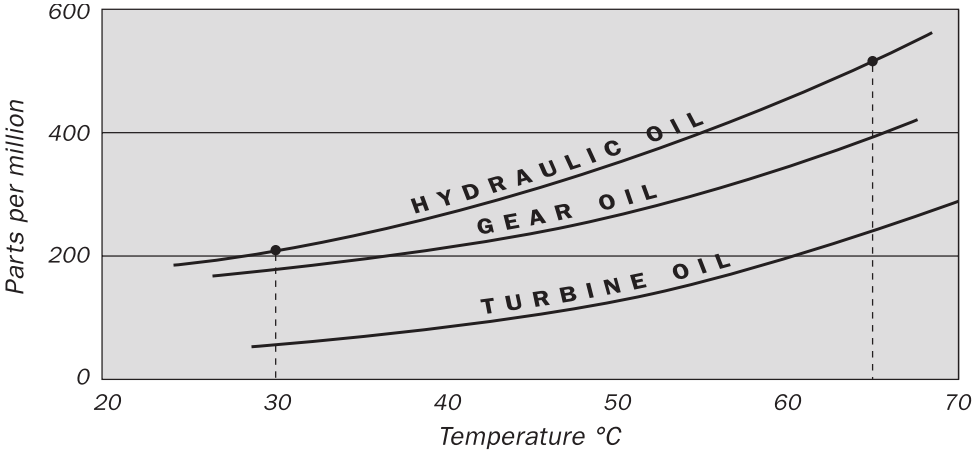


Figure I

Examples: Hydraulic oil @ 30°C = 200ppm = 100% saturation
Hydraulic oil @ 65°C = 500ppm = 100% saturation

ISO4406:1999 Cleanliness Code System

The International Standards Organization standard ISO 4406:1999 is the preferred method of quoting the number of solid contaminant particles in a sample.

The code is constructed from the combination of three scale numbers selected from the following table.

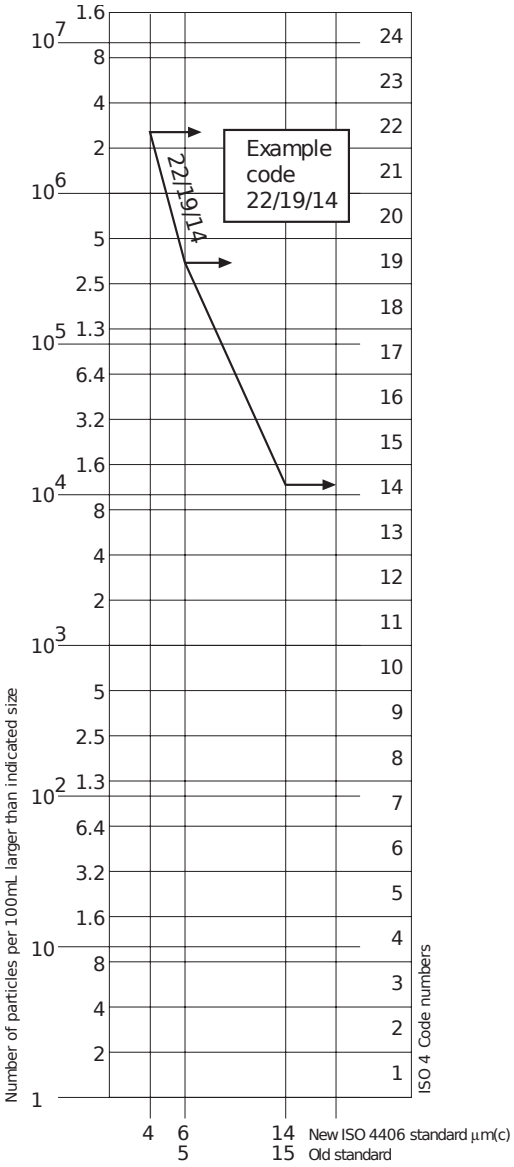
The *first* scale number represents the number of particles in a millilitre sample of the fluid that are larger than 4 µm(c).

The *second* number represents the number of particles larger than 6 µm(c).

The *third* represents the number of particles that are larger than 14 µm(c).

Number of Particles per mL		*Scale No.*
More than	*Up to and including*	
2.5M	-	> 28
1.3M	2.5M	28
640k	1.3M	27
320k	640k	26
160k	320k	25
80k	160k	24
40k	80k	23
20k	40k	22
10k	20k	21
5000	10k	20
2500	5000	19
1300	2500	18
640	1300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5.0	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0.0	0.01	0

Microscope counting examines the particles differently to APCs and the code is given with two scale numbers only. These are at 5 µm and 15 µm equivalent to the 6 µm(c) and 14 µm(c) of the APCs.



NAS1638 Cleanliness Code System

The NAS system was originally developed in 1964 to define contamination classes for the contamination contained within aircraft components. The application of this standard was extended to industrial hydraulic systems simply because nothing else existed at the time. The coding system defines the maximum numbers permitted of 100ml volume at various size intervals (differential counts) rather than using cumulative counts as in ISO 4406:1999. Although there is no guidance given in the standard on how to quote the levels, most industrial users quote a single code which is the highest recorded in all sizes and this convention is used on the LPA² software.

	00	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
5-15	125	250	500	1000	2000	4000	8000	16000	32000	64000	128000	256000	512000	1024000
15-25	22	44	89	178	356	712	1425	2850	5700	11400	22800	45600	91200	182400
25-50	4	8	16	32	63	126	253	506	1012	2025	4050	8100	16200	32400
50-100	1	2	3	6	11	22	45	90	180	360	720	1440	2880	5760
Over 100	0	0	1	1	2	4	8	16	32	64	128	256	512	1024

Figure C.I CONTAMINATION LEVEL CLASSES according to NAS1638 (January 1964).

The contamination classes are defined by a number (from 00 to 12) which indicates the maximum number of particles per 100 ml, counted on a differential basis, in a given size bracket.

Appendix D

SAE AS4059 REV.E Cleanliness Classification For Hydraulic Fluids[VIII]

This SAE Aerospace Standard (AS) defines cleanliness levels for particulate contamination of hydraulic fluids and includes methods of reporting data relating to the contamination levels. Tables 1 and 2 below provide the Maximum Contamination Limits (Particles/100ml) of differential and cumulative particle counts respectively for counts obtained by an automatic particle counter, e.g. LPA².

[VIII] The information reproduced on this and the previous page is a brief extract from SAE AS4059 Rev.E, revised in May 2005. For further details and explanations refer to the full Standard.

Size range µm(c):	6 - 14	14 - 21	21 - 38	38 - 70	>70
Class					
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	506	90	16
7	32,000	5.700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,440	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,400	32,400	5,760	1,024

Table D.I AS4059E Table 1 - Cleanliness Classes for Differential Particle Counts

Size µm(c)	>4	>6	>14	>21	>38	>70
Size Code	A	B	C	D	E	F
Classes						
000	195	76	14	3	1	0
00	390	152	27	5	1	0
0	780	304	54	10	2	0
1	1,560	609	109	20	4	1
2	3,120	1,217	217	39	7	1
3	6,250	2,432	432	76	13	2
4	12,500	4,864	864	152	26	4
5	25,000	9,731	1,731	306	53	8
6	50,000	19,462	3,462	612	106	16
7	100,000	38,924	6,924	1,224	212	32
8	200,000	77,849	13,849	2,449	424	64
9	400,000	155,698	27,698	4,898	848	128
10	800,000	311,396	55,396	9,796	1,696	256
11	1,600,000	622,792	110,792	19,592	3,392	512
12	3,200,000	1,245,584	221,584	39,184	6,784	1,024

Table D.II AS4059E Table 2 - Cleanliness Classes for Cumulative Particle Counts

Recommendations

Unit	*Type*	*ISO 4406:1999 Code*
PUMP	Piston (slow speed, in-line)	22/20/16
	Piston (high speed, variable)	17/15/13
	Gear	19/17/15
	Vane	18/16/14
MOTOR	Axial piston	18/16/13
	Radial piston	19/17/13
	Gear	20/18/15
	Vane	19/17/14
VALVE	Directional (solenoid)	20/18/15
	Pressure control (modulating)	19/17/14
	Flow control	19/17/14
	Check valve	20/18/15
	Cartridge valve	20/18/15
	Proportional	18/16/13
	Servo-valve	16/14/11
ACTUATOR		20/18/15

Table E.I Typical Manufacturers Recommendations for Component Cleanliness (ISO 4406:1999)[IX]

Most component manufacturers know the proportionate effect that increased dirt level has on the performance of their components and issue maximum permissible contamination levels. They state that operating components on

[IX] It should be noted that the recommendations made in this table should be viewed as starting levels and may have to be modified in light of operational experiences or user requirements.

fluids which are cleaner than those stated will increase life. However, the diversity of hydraulic systems in terms of pressure, duty cycles, environments, lubrication required, contaminant types, etc, makes it almost impossible to predict the components service life over and above that which can be reasonably expected. Furthermore, without the benefits of significant research material and the existence of standard contaminant sensitivity tests, manufacturers who publish recommendations that are cleaner than competitors may be viewed as having a more sensitive product.

Hence there may be a possible source of conflicting information when comparing cleanliness levels recommended from different sources.

The table gives a selection of maximum contamination levels that are typically issued by component manufacturers. These relate to the use of the correct viscosity mineral fluid. An even cleaner level may be needed if the operation is severe, such as high frequency fluctuations in loading, high temperature or high failure risk.

Hydraulic System Target Cleanliness Levels

Where a hydraulic system user has been able to check cleanliness levels over a considerable period, the acceptability, or otherwise, of those levels can be verified. Thus if no failures have occurred, the average level measured may well be one which could be made a bench mark. However, such a level may have to be modified if the conditions change, or if specific contaminant-sensitive components are added to the system. The demand for greater reliability may also necessitate an improved cleanliness level.

The level of acceptability depends on three features:

- the contamination sensitivity of the components
- the operational conditions of the system
- the required reliability and life expectancy

Contamination Codes ISO 4406:1999			Corresponding Codes NAS 1638	Recommended Filtration Degree	Typical Applications
4 µm(c)	6 µm(c)	14 µm(c)		Bx200	
14	12	9	3	3	High precision and laboratory servo-systems
17	15	11	6	3-6	Robotic and servo-systems
18	16	13	7	10-12	Very sensitive - high reliability systems
20	18	14	9	12-15	Sensitive - reliable systems
21	19	16	10	15-25	General equipment of limited reliability
23	21	18	12	25-40	Low - pressure equipment not in continuous service

The table above is a guide to the recommended filtration level for various hydraulic components, together with typical target system cleanliness levels.

New ISO Medium Test Dust and its effect on ISO Contamination Control Standards

When General Motors gave advance warning to the International Standards Organization (ISO) that it was intending to stop the production of AC Fine Test Dust (ACFTD), work commenced immediately on finding an improved replacement dust. ACFTD was used extensively within the fluid power and automotive industries for calibrating Automatic Particle Counters (APCs) and for the testing of components.

APCs are used for testing oil filters, and also for contaminant sensitivity testing of hydraulic components. For 25 years, APCs have been the main stay in the measurement of solid particles in hydraulic fluids. The growth in demand for measuring fluid cleanliness in a variety of industrial processes, including fluid power, has resulted in APCs moving from the laboratory environment out into the factory. In fact, they are now a critical part of many production processes. It is therefore essential that the data they provide is both accurate and consistent.

Calibration

ACFTD has been used as an artificial contaminant since the 1960s and its original particle size distribution was determined using an optical microscope. This particle size distribution subsequently formed the basis of ISO 4402, the method for calibrating APCs. Due to the limitations of that method of measurement, the particle size distribution was questioned below about 5µm. It was also not traceable to any national standard of measurement - a critical requirement for today's quality management systems.

There was also an absence of formal controls over the distribution of the test dust, and batch-to-batch variability was much greater than is acceptable nowadays.

ISO therefore defined the requirements for the replacement for ACFTD and asked the National Institute of Standards and Technology (NIST) in the USA to produce a standard, traceable reference material. The new dust's particle size distribution has been accurately determined with the aid of modern scanning electron microscope and image analysis techniques.

New Test Dust Benefits

The new ISO Medium Test Dust (ISO MTD) consists of similar materials to the old ACFTD, but to minimize particle counting errors, it is of a slightly coarser grade because ACFTD included too many particles smaller than 5µm which gave problems during testing.

ISO MTD is produced to a standard distribution and stringent quality control procedures, thereby ensuring excellent batch-to-batch repeatability. These procedures, combined with a revised ISO APC calibration method give:

- A traceable and controlled reference test dust with greatly reduced variation in particle size distribution. This gives the trace-ability required by ISO 9000, QS9000 and similar quality management systems.
- A procedure for determining the performance of APCs so that minimum acceptable levels can be set by the user.
- Improved calibration techniques and procedures.
- More accurate calibration.
- Improved levels of particle count reproducibility with different equipment.
- More accurate and consistent filter test results.

Effect on Industry

The introduction of ISO MTD has necessitated changes to certain ISO standards.

The standards affected include:

ISO 4402:1991 Hydraulic fluid power
Calibration of liquid automatic particle counters.

ISO 4406:1987 Hydraulic fluid power
Code for defining the level of contamination by solid particles.

ISO 4572:1981 Hydraulic fluid power – Filters
Multi-pass method for evaluating filtration performance of a filter element.

In order that users are not confused by the changes to these standards, particularly by reference to them in technical literature, ISO is updating 4402 to ISO 11171, and 4572 to ISO 16889.

Two standards which concern our industry are the ISO 4406 coding system and the new ISO 16889 Multi-pass test. As APCs will henceforth count particles more accurately, there will now be a change in the way sizes are labelled.

In the new ISO 4406:1999, new calibration sizes are used to give the same cleanliness codes as the 'old' calibration sizes of 5 and 15 µm. In this way, there will be no necessity to change any system cleanliness specifications. It is proposed that the cleanliness codes (for APCs) will be formed from three[X] particle counts at 4, 6 and 14 µm, with 6 and 14 µm corresponding very closely to the previous 5 and 15 µm measurements. This will ensure consistency in data reporting.

As the counts derived by microscope counting methods are not affected, the particle sizes used for microscopy will remain unchanged (i.e. at 5 and 15 µm).

[X] The option of quoting just two counts of 6µm and 14µm for APCs remains.

To clarify matters still further, ISO standards written around the new test dust will utilize a new identifier, '(c)'. Hence µm sizes according to the new ISO 11171 will be expresses as 'µm(c)' and Beta ratios according to ISO 16889 will be expressed as 'Bx(c)', e.g.'B5(c)'.

However, it must be stressed that the only real effect users will experience will be the improved accuracy in particle counts - there will be no change in the performance of filters, nor in the ISO cleanliness levels that they will achieve.

The following charts shows the correlation between the old ACFTD and the new ISO MTD.

The LPA² is calibrated with ISO Medium Test Dust (to ISO 11171). The correlation between particle sizes and the ACFTD (old standard) to the ISO MTD (new standard) is as follows :

ACFTD	<1	5	15	25	30	50	75	100
ISO MTD	4	6	14	21	25	38	50[XI]	70[XII]

[XI] Not verified by NIST
[XII] acftd

Correlation

The table shows the correlation between Particle Sizes Obtained using ACFTD (ISO 4402:1991) and NIST (ISO 11171) Calibration Methods

This table is only a guideline. The exact relationship between ACFTD sizes and the NIST sizes may vary from instrument to instrument depending on the characteristics of the particle counter and original ACFTD calibration.

Particle Size Obtained Using	
ACFTD (ISO 4402:1991) µm	ISO/NIST MTD (ISO 11171) µm(c)
1	4.2
2	4.6
3	5.1
4	5.8
5	6.4
6	7.1
7	7.7
8	8.4
9	9.1
10	9.8
11	10.6
12	11.3
13	12.1
14	12.9
15	13.6
16	14.4
17	15.2
18	15.9
19	16.7
20	17.5
21	18.2
22	19.0
23	19.7
24	20.5
25	21.2
26	22.0
27	22.7
28	23.5
29	24.2
30	24.9
31	25.7
32	26.4
33	27.1
34	27.9
35	28.5
36	29.2
37	29.9
38	30.5
39	31.1
40	31.7

Other Standards

Although the ISO 4406:1999 standard is being used extensively within the hydraulics industry other standards are occasionally required and a comparison may be requested. The following table gives a very general comparison

but often no direct comparison is possible due to the different classes and sizes involved.

[xiii] All section headings indicated with [] are reproduced by kind permission of British Fluid Power Association from BFPA/P5 1999 issue 3 Appendix 44

ISO 4406:1999	DEF.STD 05/42 [7]XIII		NAS 1638[5]	SAE 749[8]
	Table A	Table B	ISO 11218[6]	
13/11/08			2	
14/12/09			3	0
15/13/10			4	1
16/14/09		400F		
16/14/11			5	2
17/15/09	400			
17/15/10		800F		
17/15/12			6	3
18/16/10	800			
18/16/11		1,300F		
18/16/13			7	4
19/17/11	1,300	2000F		
19/17/14			8	5
20/18/12	2,000			
20/18/13		4,400F		
20/18/15			9	6
21/19/13	4,400	6,300F		
21/19/16			10	
22/20/13	6,300			
22/20/17			11	
23/12/14	15,000			
23/21/18			12	
24/22/15	21,000			
25/23/17	100,000			

Table I

Specification

As a policy of continual improvement, MP Filtri UK reserve the right to alter the specification without prior notice.

Technology	Automatic Optical Particle Analyser
Optical Package	Twin Laser and Twin Optical Diode Detectors
Display	Backlight graphical LCD
Sensitivity	>4,6,14,21,25,38,50,70 µm(c) sizes to revised ISO 4406: 1999 Standard
Accuracy / repeatability	Better than 3% typical
Calibration	Each unit is individually calibrated with ISO Medium Test Dust (MTD) based on ISO 11171: 1999 on equipment certified by I.F.T.S.
Analysis Range	ISO 8 to ISO 24 to ISO 4406: 1999 NAS 1638: 2 to 12 AS4059E Table 1: 2 to 12 AS4059E Table 2: Size Codes A: 000 to 12, B: 00 to 12, C: 00 to 12, D: 2 to 12, E: 4 to 12, F: 7 to 12
Report / Print Format	ISO4406:1999, NAS1638 and AS4059E codes / classes with individual particle counts as a built-in option
Printer	Fixed head thermal printer (384 dots per line)

LPA² Sample volume	15 ml. (normal) 30 ml. (dynamic) 24 ml. (bottle sampler) 15 ml. (continuous) 8ml. (short)
Operation	Max. system working pressure: 400 bar. Min. working pressure: 2 bar
Viscosity range	to 400 centistokes
Operating temperature	+5 to +80°C
Fluid compatibility	Mineral oil & petroleum based fluids (consult MP Filtri UK for other fluids)
Typical test time	Result in <2.5 mins. (normal test)
Power	Internal rechargeable battery (mains charger) or External 12/24 volt DC power supply.
Data storage	600 tests
Computer interface	RS 232 communication port
Hose connections	Minimess fittings Microbore hose 1.5 metres long Waste fluid hose
Dimensions	Height 210mm Depth 260mm Width 430mm Weight 7.6kg

Spare Product / Part Numbers

For spares and part numbers please see the website:

www.mpfiltri.co.uk

COM Ports

The LPA² uses the RS232 connection standard to interface with a computer. If the computer does not have a built-in RS232 ("COM'') port, a USB:RS232 adaptor can be used.

Connection Using a USB Port

This is used when a built-in RS232 port is not available. When using a USB Adaptor provided with the LPA²:

- Install the Prolific driver from the file:

  PL2303_Prolific_DriverInstaller_v110.exe

  on the provided CD.

- You will need to accept any warnings about making changes to your computer.

- Follow the installer Wizard, accepting the defaults.

- When the installer has completed, plug in the USB to Serial Adaptor.

- A message should pop up indicating successful hardware installation. Note any COM port number indicated in the message.

- Connect the LPA² to the computer using the Serial lead and the USB to Serial Converter.

- If neccessary, determine the COM port allocated by the computer for this device using the procedure following.

Determining the COM Port

To check the COM port number allocated by the computer for the Serial lead or the USB to Serial Connector:

- *Windows 2000, Windows XP, Windows Vista*

  — Right click on My Computer icon and then left click on Properties.

  — Click on the Hardware tab and then click on the Device Manager Button.

  — Click on the plus sign next to Ports (COM & LPT).

  Windows 7

  — View the installed devices using Start Button/Devices and Printers.

- You should see an icon representing the port.

  — "Communications port''- if using the Serial lead.

  — "ATEN USB to Serial Cable'' or "Prolific USB-to-Serial Comm Port'' if using an adaptor cable.

  Either of these will have a COM number after it. This is the number you should use when selecting the Com Port.

Fault Finding

FAULT	CHECK
LCD Screen remains blank after switching on	Check that Analyser had been put on charge previously Check that LED illuminates when power adaptor is connected to Analyser DC Power Input Socket
Unexpected results obtained from sample	Check that the fluid sampling hose has been fully connected at both the system and Analyser ends Confirm that there is a free flow of fluid to the Analyser, by depressing the Flush Valve and observing fluid passing into the waste disposal bottle High water/aeration levels. (If suspected contact MP Filtri UK for further advice)

If excessive system contamination is suspected, flush out the Analyser using a Bottle Sampling Unit in conjunction with a suitable solvent.

The standard LPA² and the standard Bottle Sampling units are both fitted with Nitrile seals, so Petroleum Ether may be used for this purpose.

Petroleum Ether is not compatible with seals manufactured from EPDM, which are used in the Phosphate Ester version of the 250 Bottle Sampling unit. Iso-propyl alcohol should be used as the flushing fluid. Please consult the website for other compatible fluids.

DO NOT USE ACETONE

Produced by MP Filtri UK

Revision 15

As a policy of continual improvement, MP Filtri UK reserve the right to alter specifications without prior notice.

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